SECTION 07 51 00.11
BUILT-UP BITUMINOUS ROOFING, HOT-APPLIED

PART 1 - GENERAL

1.1 DESCRIPTION

A. This section includes hot-applied bituminous [hybrid] built-up roofing solar reflective granular coating.

1.2 RELATED WORK

A. Wood cants, blocking, and wood edge strips: Section 06 10 00, ROUGH CARPENTRY.
B. Roof Insulation: Section 07 22 00, ROOF AND DECK INSULATION.
C. Vapor barrier: Section 07 22 00, ROOF AND DECK INSULATION.
D. Sheet metal components and wind uplift requirements for roof-edge design: Section 07 60 00, FLASHING AND SHEET METAL.

1.3 APPLICABLE PUBLICATIONS

A. Publications listed below form a part of this specification to the extent referenced. Publications are referenced in the text by the basic designation only. Editions of applicable publications current on date of issue of bidding documents apply unless otherwise indicated.
B. American National Standards Institute/Single-Ply Roofing Institute (ANSI/SPRI):
ANSI/SPRI ES-1-03 ..... Wind Design Standard for Edge Systems Used with Low Slope Roofing Systems
C. American Society of Civil Engineers/Structural Engineering Institute (ASCE/SEI):
ASCE/SEI-7-10 ..... Minimum Design Loads for Buildings and Other Structures
D. Asphalt Roofing Manufacturers Association/National Roofing Contractors Association (ARMA/NRCA): Quality Control Guidelines for the Application of Polymer Modified Bitumen Roofing
E. ASTM International (ASTM):
C67-09..... Standard Test Methods for Sampling and Testing Brick and Structural Clay Tile
C140-09..... Standard Test Methods for Sampling and Testing Concrete Masonry Units and Related Units
C1370-00(R2005)..... Standard Test Method for Determining the Chemical Resistance of Aggregates for Use in Chemical-Resistant Sulfur Polymer Cement Concrete and Other Chemical-Resistant Polymer Concretes

C1371-04.....Standard Test Method for Determination of Emittance of Materials Near Room Temperature Using Portable Emissometers

C1549-04.....Standard Test Method for Determination of Solar Reflectance Near Ambient Temperature Using a Portable Solar Reflectometer

D146-04.....Standard Test Methods for Sampling and Testing Bitumen-Saturated Felts and Woven Fabrics for Roofing and Waterproofing

D312-00(R2006).....Standard Specification for Asphalt Used in Roofing

D448-00(R2006).....Sizes of Aggregate for Road and Bridge Construction

D751-06.....Test Methods for Coated Fabrics

D1644-01(R2006).....Standard Test Methods for Nonvolatile Content of Varnishes

D1863-05.....Mineral Aggregate Used on Built-Up Roofs

D2178-04.....Asphalt Glass Felt Used in Roofing and Waterproofing

D2523-00(R2006).....Standard Practice for Testing Load-Strain Properties of Roofing Membranes

D3884-09.....Abrasion Resistance of Textile Fabrics (Rotary Platform Double-Head Method)

D3909-97(R2004).....Asphalt Roll Roofing (Glass Felt) Surfaced with Mineral Granules

D3960-05.....Standard Practice for Determining Volatile Organic Compound (VOC) Content of Paints and Related Coatings

D4073-06.....Standard Test Method for Tensile-Tear Strength of Bituminuous Roofing Membranes

D4263-83(2005) .....Standard Test Method for Indicating Moisture in Concrete by the Plastic Sheet Method

D4586-07.....Asphalt Roof Cement, Asbestos Free

D4601-04.....Standard Specification for Asphalt-Coated Glass Fiber Base Sheet Used in Roofing

D4897-01.....Asphalt Coated Glass Fiber Venting Base Sheet Used in Roofing

D5147-07.....Standard Test Methods for Sampling and Testing Modified Bituminous Sheet Material

D5201-05(2010) .....Standard Practice for Calculating Formulation Physical Constants of Paints and Coatings

D6162-00(R2008).....Styrene Butadiene Styrene (SBS) Modified Bituminous Sheet Materials Using a Combination of Polyester and Glass Fiber Reinforcements

D6163-00(R2008)..... Styrene Butadiene Styrene (SBS) Modified Bituminous Sheet Materials Using Glass Fiber Reinforcements

D6164-05..... Styrene Butadiene Styrene (SBS) Modified Bituminous Sheet Materials Using Polyester Reinforcements

D6511-06..... Standard Test Methods for Solvent Bearing Bituminous Compounds

E108-10..... Standard Test Methods for Fire Tests of Roof Coverings

E408-71(R2008)..... Standard Test Methods for Total Normal Emittance of Surfaces Using Inspection-Meter Techniques

E1918-06..... Standard Test Method for Measuring Solar Reflectance of Horizontal and Low-Sloped Surfaces in the Field

E1980-01..... Standard Test Method for Measuring Solar Reflectance of Horizontal and Low-Sloped Surfaces in the Field

WK29032-10 ..... Standard Test Method for Determination of Solar Reflectance Near Ambient Temperature Using a Portable Solar Reflectometer

F. American Society of Heating, Refrigeration, and Air Conditioning Engineers (ASHRAE)

ASHRAE 90.1-2007 ..... Energy Standard for Buildings Except Low-Rise Residential Buildings, Appendix f.

G. Cool Roof Rating Council:

CRRC-1..... Product Rating Program, www.coolroofs.org

H. FM Approvals: RoofNav Approved Roofing Assemblies and Products.

4450-89 ..... Approved Standard for Class 1 Insulated Steel Deck Roofs

4470-10 ..... Approved Standard for Class 1 Roof Coverings

1-28-09..... Loss Prevention Data Sheet: Design Wind Loads.

1-29-09..... Loss Prevention Data Sheet: Above-Deck Roof Components

1-49-09..... Loss Prevention Data Sheet: Perimeter Flashing

I. National Roofing Contractors Association: Roofing and Waterproofing Manual

J. U.S. Environmental Protection Agency (EPA):

EPA 600/R13/116-02 ..... Method for the Determination of Asbestos in Bulk Building Materials

K. U.S. Department of Agriculture (USDA): USDA BioPreferred Catalog, www.biopreferred.gov

L. U.S. Department of Energy (DoE): Roof Products Qualified Product List, www.energystar.gov

1.4 PERFORMANCE REQUIREMENTS

A. Material Compatibility: Provide roofing materials that are compatible with one another under conditions of service and application required, as demonstrated by membrane roofing manufacturer based on testing and field experience.

B. Roofing Membrane System Load-Strain Properties: Provide a roofing membrane identical to component systems that have been successfully tested by a qualified independent testing and inspecting agency to meet the following minimum load-strain properties at membrane failure when tested according to ASTM D2523:

1. Tensile strain at failure, at 0 deg F (-18 deg C):600 lbf(2.67 kN) percent elongation at break.

C. Roofing System Energy Performance Requirements: Provide a roofing system identical to components that that have been successfully tested by a qualified independent testing and inspecting agency to meet the following requirements:

1. Energy Performance, Energy Star: Provide roofing system that is listed on DOE's ENERGY STAR "Roof Products Qualified Product List" for low-slope roof products.
2. Solar Reflectance Index: Not less than 78 when calculated according to ASTM E1980 based on testing identical products by a qualified testing agency.
3. Energy Performance, CRRC-1: Provide roofing system with initial solar reflectance not less than 0.70 and emissivity not less than 0.75 when tested according to CRRC-1.
4. Energy Performance, Aged: Provide roofing system with minimum three-year aged solar reflectance not less than 0.55 when tested in accordance with ASTM C1549 or ASTM E1918, and in addition, a minimum three-year-aged thermal emittance of 0.75 when tested in accordance with ASTM C1371 or ASTM E408.
    a. Where tested aged values are not available for proposed product, submit calculations to adjust initial solar reflectance to demonstrate compliance as indicated in ASHRAE 90.1-2007 Addendum f.
    b. Alternatively, provide roofing system with minimum three-year aged Solar Reflectance Index of not less than 64 when determined in accordance with the Solar Reflectance Index method in ASTM E1980 using a convection coefficient of 2.1 BTU/h-ft2 (12 W/m2K).

1.5 QUALITY CONTROL

A. Installer Qualifications:

1. Licensed or approved in writing by manufacturer to perform work under warranty requirements of this Section.
2. Employ full-time supervisors knowledgeable and experienced in roofing of similar types and scopes, and able to communicate with owner and workers.

B. Inspector Qualifications: Inspection of work by third-party technical inspector or technical representative of manufacturer experienced in the installation and maintenance of the specified

roofing system, qualified to perform roofing observation and inspection specified in Field Quality Control Article, to determine Installer's compliance with the requirements of this Project, and approved by the manufacturer to issue warranty certification. The Roofing Inspector shall be one of the following:

1. An authorized full-time technical employee of the manufacturer, not engaged in the sale of products.
2. An independent party certified as a Registered Roof Observer by the Roof Consultants Institute (RCI), retained by the Contractor or the Manufacturer and approved by the Manufacturer.

C. Product/Material Requirements:

1. Obtain products from single manufacturer or from sources recommended by manufacturer for use with roofing system and incorporated in manufacturer's warranty.
2. Provide manufacturer's label on each container or certification with each load of bulk bitumen, indicating Flash Point (FP), Finished Blowing Temperature (FBT), Softening Point (SP), Equiviscous Temperature (EVT).
3. Provide manufacturer's certification that field applied bituminous coatings and mastics, and field applied roof coatings comply with limits for Volatile Organic Compounds (VOC) per the National Volatile Organic Compound Emission Standards for Architectural Coatings pursuant to Section 183(e) of the Clean Air Act with limits as follows:
   a. Bituminous Coatings and Mastics: 500 g/l (4.2 lb/gal.).
   b. Roof Coatings: 250 g/l (2.1 lb/gal.).
4. Bio-Based Materials: Where applicable, provide products designated by USDA and meeting or exceeding USDA recommendations for bio-based content, and products meeting Rapidly Renewable Materials and certified sustainable wood content definitions; refer to www.biopreferred.gov.

D. Roofing system design standard requirements:

1. Recommendations of the NRCA "Roofing and Waterproofing Manual" applicable to modified bituminous sheet roofing for storage, handling and application.
2. Recommendations of FM Approvals 1-49 Loss Prevention Data Sheet for Perimeter Flashings.
3. Recommendations of ANSI/SPRI ES-1 for roof edge design.
4. FM Approvals Listing: Provide roofing membrane, base flashing, and component materials that comply with requirements in FM Approvals 4450 and FM Approvals 4470 as part of a roofing system and that are listed in FM Approvals "RoofNav" for Class 1 or noncombustible construction, as applicable. Identify materials with FM Approvals markings.
   a. Fire/Windstorm Classification: Class 1A-90.
   b. Hail Resistance: MH.

E. Pre-Roofing Meeting:
   1. Upon completion of roof deck installation and prior to any roofing application, hold a pre-roofing meeting arranged by the Contractor and attended by the Roofing Inspector, Material Manufacturers Technical Representative, Roofing Applicator, Contractor, and Resident Engineer.
   2. Discuss specific expectations and responsibilities, construction procedures, specification requirements, application, environmental conditions, job and surface readiness, material storage, and protection.
   3. Inspect roof deck at this time to:
      a. Verify that work of other trades which penetrates roof deck is completed.
      b. Determine adequacy of deck anchorage, presence of foreign material, moisture and unlevel surfaces, or other conditions that would prevent application of roofing system from commencing or cause a roof failure.
      c. Examine samples and installation instructions of manufacturer.

1.6 SUBMITTALS

A. Submit in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, SAMPLES.
B. Product Data:
   1. Asphalt and adhesive materials.
   2. Base and ply sheet roofing and flashing membrane.
   3. Roofing cement.
   4. Fastening requirements.
   5. Roof walkway.
   6. Aggregate surfacing and surfacing adhesive.
   7. Application instructions.
C. LEED and Federal Sustainable Design Submittals:
   1. Product Test Reports for Credit SS 7.2: For roof materials, indicating that roof materials comply with Solar Reflectance Index requirement.
   2. Product Data for Credit IEQ 4.1: For adhesives and sealants used inside the weatherproofing system, documentation including printed statement of VOC content.
   3. Product Data for Federally-Mandated Bio-Based Materials: For roof materials, indicating USDA designation and compliance with definitions for bio-based products, Rapidly Renewable Materials, and certified sustainable wood content.
D. Samples:
   1. Nails and fasteners, each type.
E. Shop Drawings: Include plans, sections, details, and attachments.
   1. Base flashings and terminations.
   2. Nailers and cants.

F. Certificates:
   1. Indicating materials and method of application of roofing system meets requirements of FM Approvals "RoofNav" for specified fire/windstorm classification.
   2. Indicating compliance with energy performance requirement.
G. Warranty: As specified.
H. Documentation of supervisors' and inspectors' qualifications.
I. Field reports of roofing inspector.
J. Temporary protection plan. Include list of proposed temporary materials.
K. Contract Close-out Submittals:
   1. Maintenance Manuals.
   2. Warranty signed by installer and manufacturer.

1.7 DELIVERY, STORAGE AND MARKING

A. Comply with the recommendations of the NRCA "Roofing and Waterproofing Manual" applicable to built-up roofing for storage, handling and installation.

1.8 ENVIRONMENTAL REQUIREMENTS

A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit roofing system to be installed according to manufacturer's written instructions and warranty requirements.
B. Protection of interior spaces: Refer to Section 01 00 00, GENERAL REQUIREMENTS.

1.9 WARRANTY

A. Roofing system is subject to terms of "Warranty of Construction", FAR clause 52.246-21, except that warranty period is extended to 20 years.

PART 2 – PRODUCTS

2.1 ADHESIVE AND ASPHALT MATERIALS:

A. General: Adhesive and sealant materials recommended by roofing system manufacturer for intended use, identical to materials utilized in approved listed roofing system, and compatible with roofing membrane.
   1. Liquid-type auxiliary materials shall comply with VOC limits of authorities having jurisdiction.
   2. Adhesives and sealants that are not on the exterior side of weather barrier shall comply with the following limits for VOC content when calculated according to 40 CFR 59, Subpart D (EPA Method 24):
      a. Multipurpose Construction Adhesives: 70 g/L.
      b. Contact Adhesives: 80 g/L.
      c. Other Adhesives: 250 g/L.

d. Nonmembrane Roof Sealants: 300 g/L.
e. Sealant Primers for Nonporous Substrates: 250 g/L.
f. Sealant Primers for Porous Substrates: 775 g/L.

B. Water-Based Asphalt Primer: Water-based, polymer modified, asphalt primer with the following physical properties:
1. Asbestos Content, EPA 600/R13/116: None.
2. Volatile Organic Compounds (VOC), maximum, ASTM D 3960: 65 g/L.

C. Asphalt: ASTM D312, Type III or IV for roof membrane. Use Type I for pour coat unless specified otherwise.

D. Cold-Applied Adhesive for membrane flashing: One-part, cold-applied adhesive specially formulated for compatibility and use with specified roofing membranes and flashings, with the following physical properties:
1. Asbestos Content, EPA 600/R13/116: None.
2. Volatile Organic Compounds (VOC), maximum, ASTM D 6511: <250 g/L.
3. Nonvolatile Content, minimum, ASTM D 6511: 75 percent.
4. Uniformity and Consistency, ASTM D 6511: Pass.

E. Roof Cement: ASTM D4586, Type II.

2.2 MEMBRANE AND SHEET MATERIALS:

A. Membrane Materials, General: Provide combination of base, ply, and cap sheet materials that have been tested in combination and comply with load/strain properties performance requirement in Part 1 of this Section.

B. Base Sheet: ASTM D 4601, Type II, nonperforated, asphalt-impregnated and coated glass-fiber sheet dusted with fine mineral surfacing on both sides, with the following properties:
1. Breaking Strength, minimum, ASTM D 146: cross machine direction, 12.2 kN/m (70 lbf/in).
2. Pliability, 12.7 mm (1/2 inch) radius bend, ASTM D 146: No failures.

C. Base Sheet, Venting: ASTM D 4897, Type II, venting, nonperforated heavyweight, asphalt-impregnated and coated, glass-fiber base sheet with coarse granular surfacing or embossed venting channels on bottom surface.

D. Base Sheet: ASTM D4601, Type II or III, nonperforated, asphalt-coated, composite polyester/fiberglass/polyester reinforced sheet dusted with fine mineral surfacing on both sides, with the following properties:
1. Breaking Strength, minimum, ASTM D 146: cross machine direction, 21.0 kN/m (120 lbf/in).
2. Tear Strength, minimum, ASTM D 4073: cross machine direction, 880 N (200 lbf).
3. Pliability, 12.7 mm (1/2 inch) radius bend, ASTM D 146: No failures.

E. Ply Sheet: ASTM D2178, Type VI, heavy-duty ply sheet.
1. Breaking Strength, minimum, ASTM D 146: machine direction, 80 lbf/in (14.0 kN/m); cross machine direction, 80 lbf/in (14.0 kN/m).F.

F. Cap Sheet: ASTM D6163, Grade G, Type II, glass-fiber-reinforced, SBS-modified asphalt sheet; granular surfaced with a factory applied, white, reflective, acrylic coating; CRRC listed and California Title 24 Energy Code compliant; and as follows:
   1. Exterior Fire-Test Exposure, ASTM E108: Class A.
   2. Tensile Strength at 23 deg. C (73 deg. F), minimum, cross machine direction, ASTM D5147: 12.2 kN/m (70 lbf/in).
   3. Tear Strength at 23 deg. C (73 deg. F), minimum, cross machine direction, ASTM D5147: 440 N (100 lbf).
   4. Elongation at 23 deg. C (73 deg. F), minimum, cross machine direction, ASTM D5147: 7.5 percent.
   5. Low Temperature Flex, maximum, ASTM D5147, -26 deg. C (-15 deg. F).
   7. Reflectance, ASTM C1549: 71 percent.
   8. Thermal Emittance, ASTM C1371: 0.87.
   . Solar Reflectance Index (SRI), ASTM E1980: 87.

G. Base Flashing Backer Sheet: ASTM D4601, Type II, asphalt-impregnated and coated, glass-fiber sheet, dusted with fine mineral surfacing on both sides.

H. Base Flashing Backer Sheet: Same as ply sheet.

I. Base Flashing Sheet: ASTM D6164, Grade G, Type II, polyester-reinforced, SBS-modified asphalt sheet; granular surfaced; Granule Color: White.

2.3 FASTENERS

A. Roofing Fasteners: Factory-coated steel fasteners and metal or plastic plates, where applicable, meeting requirements of FM Approvals 4470, tested by fastener manufacturer for required pullout strength, and recommended by roofing manufacturer for application.

B. Accessory Fasteners: Corrosion-resistant fasteners compatible with adjacent materials and recommended for application by manufacturer of component to be fastened.

2.4 ROOF WALKWAY:

A. Prefabricated asphalt plank consisting of a homogeneous core of asphalt, plasticizers and inert fillers, bonded by heat and pressure between two saturated and coated sheets of felt:
   1. Top side of plank surfaced with ceramic granules. Granule Color: White.
   2. Size: Minimum 13 mm (1/2-inch) thick, manufacturer's standard size, but not less than 300 mm (12 inches) in least dimension and 600 mm (24 inches) in length.

PART 3 – EXECUTION

3.1 EXAMINATION:

A. Examine substrates and conditions with roofing Installer and roofing inspector to verify compliance with project requirements and suitability to accept subsequent roofing work. Correct unsatisfactory conditions before proceeding with roofing work.

B. Do not apply roofing if roof surface will be used for subsequent work platform, storage of materials, or staging or scaffolding will be erected thereon unless system is protected.

3.2 PREPARATION

A. Complete roof deck construction prior to commencing roofing work:
   1. Install curbs, blocking, edge strips, nailers, cants, and other components where insulation, roofing, and base flashing is attached to, in place ready to receive insulation and roofing.
   2. Complete deck and insulation to provide designed drainage to working **roof drains.**
   3. Document installation of related materials to be concealed prior to installing roofing work.

B. Dry out surfaces, including the flutes of metal deck that become wet from any cause during progress of the work before roofing work is resumed. Apply materials to dry substrates.

C. Sweep decks to broom clean condition. Remove all dust, dirt or debris.

D. Remove projections that might damage materials.

E. Concrete Decks, except Insulating Concrete:
   1. Test concrete decks for moisture prior to application of roofing materials. Test for capillary moisture by plastic sheet method according to ASTM D4263.
   2. Test concrete decks for moisture by pouring one pint of hot bitumen at 204 degrees C (400 degrees F.) or EVT on deck at start of each day's Work and at start of each new roof area or plane. Do not proceed if test sample foams or can be easily (cleanly) stripped after cooling.
   3. Prime concrete decks, including precast units, with primer as specified. Keep primer back four inches from joints in precast units.
   4. Allow primer to dry before application of bitumen.

F. Poured Gypsum Decks: Dry out poured gypsum in accordance with manufacturer's printed instructions prior to application of roofing materials.

G. Fume Management for Roofing at Occupied Facilities:
   1. Use fume recovery system for hot-applied installations when directed by Owner
   2. Operate large fans during placement of hot-applied asphalt to direct airflow away from operating intake louvers.

3.3 HEATING BITUMEN

A. Heat the asphalt to the equiviscous temperature plus or minus -4 deg. C (25 deg. F) at the time of application:

1. Do not heat asphalt greater than 38 deg. C (100 deg. F) above the equiviscous temperature.
2. When the equiviscous temperature is not furnished by the asphalt manufacturer, do not heat asphalt above 275 deg. C (525 deg. F) for Type III and IV with temperature not less than 250 deg. C (475 deg. F) at time of application.

B. Do not heat bitumen above the flash point temperature.

C. Provide heating kettles with a thermometer kept in operating condition. Attend kettle during heating to insure that the bitumens are heated within the temperatures specified.

D. Use type III and Type IV asphalt between plies.

E. Do not mix different type of asphalt in kettle.

3.4 TEMPORARY PROTECTION

A. Install temporary protection at the end of day's work and when work is halted for an indefinite period or work is stopped when precipitation is imminent. Comply with approved temporary protection plan.

B. Install temporary cap flashing over the top of base flashings where permanent flashings are not in place to provide protection against moisture entering the roof system through or behind the base flashing. Securely anchor in place to prevent blow off and damage by construction activities.
   1. Glaze coat exposed surfaces of felts to seal within the bitumen coating. Do not leave felt surfaces or edges exposed.

C. Provide for removal of water or drainage of water away from the work.

D. Provide temporary protection over installed roofing by means of duckboard walkways, plywood platforms, or other materials, as approved by Resident Engineer, for roof areas that are to remain intact, and that are subject to foot traffic and damage. Provide notches in sleepers to permit free drainage.

3.5 INSTALLATION, GENERAL

A. FM Approvals Installation Standard: Install roofing membrane, base flashings, wood cants, blocking, curbs, and nailers**,** and component materials in compliance with requirements in FM 4450 and FM 4470 as part of a membrane roofing system as listed in FM Approval's "RoofNav" for fire/windstorm classification indicated. Comply with recommendations in FM Approvals' Loss Prevention Data Sheet 1-49, including requirements for wood nailers and cants.

B. NRCA Installation Standard: Install roofing system in accordance with applicable NRCA Manual Plates and NRCA recommendations, including ARMA/NRCA's "Quality Control Guidelines for the Application of Polymer Modified Bitumen Roofing"

C. Manufacturer Recommendations: Comply with roofing system manufacturer's written installation recommendations.

D. Coordination with related work: Coordinate roof operations with roof insulation and sheet metal work so that insulation and flashings are installed concurrently to permit continuous roofing operations.

E. Installation Conditions:

1. Apply dry roofing materials. Apply roofing work over dry substrates and materials.
2. Apply materials within temperature range and surface and ambient conditions recommended by manufacturer.
3. Except for temporary protection, do not apply materials during damp or rainy weather, during excessive wind conditions, nor while moisture (dew, snow, ice, fog or frost) is present in any amount in or on the materials to be covered or installed:
    a. Do not apply materials when the temperature is below 4 deg. C (40 deg. F).
    b. Do not apply materials to substrate having temperature of 4 deg. C (40 deg. F) or less.

3.6 INSTALLATION OF BUILT-UP BITUMINOUS ROOFING

A. Primer: Apply primer to substrates where recommended by roofing manufacturer, in application quantities recommended by roofing manufacturer.

B. Hot Roofing Asphalt: Apply hot roofing asphalt in quantities required, immediately followed by membrane materials embedded therein before bitumen cools below the application temperature limit.

1. Provide uniform and positive adhesion between all installed materials, including adhesion to insulation or substrate, and between each ply of felt.
2. Do not apply more material than can be covered at one time except for glaze coats.
3. Recoat cooled areas.
4. Do not allow bitumen to penetrate joints or enter building. Where mopping is applied directly to a substrate, tape joints. When applying steep asphalt, hold mopping back 50mm (2 inches) from each side of joint.

C. Application Rates:

1. Between substrate and sheets and between plies: 10 to 17.5 kg per 10 sq. m (20 to 35 lbs per 100 sq. ft.).
2. Glaze coats: 7 to 11 Kg per 10 sq. m (15 to 25 lbs per 100 sq. ft.).
3. Pour coats: 25 to 30 Kg per 10 sq. m (55 to 65 lbs per 100 sq. ft.).
4. Provide asphalt quantities within the indicated ranges, unless recommended otherwise in the roofing materials manufacturer's printed data.

D. Cold-Applied Adhesive:

1. Apply cold-applied adhesive in a uniform application at rate recommended by manufacturer.

E. Built-Up Membrane Sheets:

1. Number of Plies: [4], minimum, including cap sheet, and not including base sheet if any. Provide additional plies as required to meet load/strain properties specified in Part 1 of this Section.
2. Commence the laying of sheets at the low points.
3. Roll sheets into hot roofing asphalt brushing down to firmly embed, free of wrinkles, fish mouths, blisters, bubbles, voids, air pockets or other defects that prevent complete adhesion:
4. Cut to fit closely around pipes, roof drains, bitumen stops, and similar roof projections.
5. Lap sheets shingle fashion starting with starter strips at right angles to slope of roof.
6. Laps for base sheet and ply sheets:
    a. Base sheet, lapped 50 mm (2-inches).
    b. Two plies with 450 mm (18-inches) and 900 mm (36-inch) starting widths, lapped 480 mm (19-inches).
    c. Three plies with 300 mm (12-inches) 600 mm (24-inches) and 900 mm (36-inch) starting widths, lapped 624 mm (24-1/2 inches).
    d. Four plies with 230, 460, 690 and 900 mm (9, 18, 27 and 36-inch) starting widths, lapped 700 mm (27-1/2 inches).
    e. End joints of ply and base sheet, lapped 50 mm (2-inches). Stagger end joints in relation to joints in adjacent and proceeding plies.

F. Roof edges and terminations:
1. Where nailers occur at roof edges under gravel stops or penetrations to receive metal base flashing, apply a continuous strip of underlayment over the nailers before the first ply sheet is applied. Strip shall be installed on top of venting base sheet if any.
2. After membrane is installed, turn the underlayment back over the roofing, and secure in place with hot roofing asphalt before gravel stops or other metal flanges extending out onto the membrane are installed.
3. Where cants occur at vertical surfaces, cut off roofing sheets two inches above top of cant strips, except at prefabricated curbs, scuttles and other roof accessories having integral cants, extend membrane over cant and up vertical surface to top of curb or nailer as shown.
4. Where fascia-cant occurs at roof edges, extend membrane beyond outside cant face and cut off at outside after base flashing is installed.
5. Where reglet occurs at vertical surfaces, extend plies roofing sheets up into reglet the full depth of the reglet.

G. Base Sheet Installation:
1. One ply of base sheet dry to deck, except mop between laps. Lap and attach as specified to deck.

H. Venting Base Sheet Installation:
1. At vertical surfaces: Extend venting base sheet up vertical surface over cants to top of base flashing or curb.

2. At roof edge under gravel stops install venting base sheet over blocking: Extend base sheet not less than 50 mm (2-inches) beyond outer edge and turn down to allow venting at the edge.
3. At roof edge over fascia-cant: Extend base sheet over top of cant and turn down over outer face of cant to allow venting at the edge.

I. Roof Ply Installation:
1. Extend first ply sheet 100 mm (4-inches) beyond the insulation and the second ply sheet 75 mm (3-inches) beyond the first. Lap ends 75 mm (3-inches) with joints broken 450 mm (18-inches) in each ply.

J. Cap Sheet Installation:
1. Install cap sheet in a solid mopping of hot asphalt.
2. Extend cap sheet 100 mm (4-inches) beyond the underlying ply 75 mm (3-inches). Lap ends 75 mm (3-inches) with joints broken 450 mm (18-inches) in each ply.

3.7 BASE FLASHING:

A. Prime vertical surfaces of masonry and concrete with asphalt primer except where vented base sheet is required to provide edge venting.

B. Apply flashing on top of built-up roofing, up face of cant and vertical surfaces, at least 200 mm (8-inches) above the roof, full height beneath counter flashing or top of curb flashing:
1. At fascia-cants, extend to top of cant and cut off.
2. Extend plies of roofing into reglet the full depth of the reglet.

C. Except at metal fascia cants, secure top edge of base flashing with nails on a line approximately one inch below top edge, spaced not more than 200 mm (8-inches) on center.
1. Cover all nail heads with roof cement.
2. Cover the top of the base flashing with counter flashing as specified in Section 07 60 00, FLASHING AND SHEET METAL. At the cants secure the top edge of the flashing with fascia compression clamp as specified in Section 07 60 00, FLASHING AND SHEET METAL.

D. Install flashing using longest pieces practicable. Complete splices between flashing and main roof sheet before bonding to vertical surface. Seal splice not less than 76mm (3-inches) beyond fasteners that attach membrane to blocking. Apply bonding adhesive to both flashing and surface to which flashing is being adhered per manufacturer recommendations. Nail top of flashing 300mm (12-inches) on center under metal counter flashing or cap.
1. Parapet Walls: Extend up parapet and turn over top edge. Apply with 100 percent adhesive.

E. Install flashing over cants to make system watertight.

F. Install flashing before final roofing coat and aggregate are installed.

3.8 STRIPPING:

A. Set flanges of metal flashing in roof cement before the final bituminous coat and roof aggregate are installed and nail to blocking per Section 07 60 00, FLASHING AND SHEET METAL.

B. Before the final bituminous coat and aggregate are installed, cover that portion of the horizontal flanges of metal base flashing, gravel stops and other flanges, extending onto the roofing with flashing sheet.

3.9 ROOF WALKWAYS:

A. Install roof walkways where shown.

B. Set prefabricated planks in solid application of cold-applied adhesive. Maintain 75 mm (three inch) to 150 mm (six-inch) space between planks.

3.10 FIELD QUALITY CONTROL

A. Roofing Inspector: Owner will engage a qualified roofing inspector to perform roof tests and inspections and to prepare test reports.

B. Roofing Inspector: Contractor shall engage a qualified roofing inspector for a minimum of [5] [7] [10] full-time days on site to perform roof tests and inspections and to prepare start up, interim, and final reports. Roofing Inspector's quality assurance inspections shall comply with criteria established in ARMA/NRCA's "Quality Control Guidelines for the Application of Built-up Roofing."

C. Final Roof Inspection: Arrange for roofing system manufacturer's technical personnel to inspect roofing installation on completion.

   1. Notify Architect and Owner 48 hours in advance of date and time of inspection.

D. Repair or remove and replace components of roofing work where test results or inspections indicate that they do not comply with specified requirements.

   1. Additional testing and inspecting, at Contractor's expense, will be performed to determine if replaced or additional work complies with specified requirements.

3.16 PROTECTING AND CLEANING

A. Protect membrane roofing system from damage and wear during remainder of construction period.

B. Correct deficiencies in or remove membrane roofing system that does not comply with requirements; repair substrates; and repair or reinstall membrane roofing system to a condition free of damage and deterioration at time of acceptance by Owner.

C. Clean overspray and spillage from adjacent construction. Clean membrane and restore surface to like-new condition meeting solar reflectance requirements.

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